Growth of two wetland plants under varying hydrologic regimes

Romi L. Burks and William J. Mitsch

Olentangy River Wetland Research Park
School of Natural Resources, The Ohio State University

Introduction

Excess nutrients continue to pour into our nation's freshwater resources. Severe consequences of this cultural eutrophication, as evidenced by a growing expanse of hypoxia in coastal waters, readily occur downstream of excessive nutrient inputs. The scientific community unquestionably identifies nitrogen, coming from fertilizers, livestock and land-use changes, as the primary culprit to hypoxia in the Gulf of Mexico. Creating and restoring wetlands as riparian buffers between agricultural and livestock areas and freshwater is one approach to combating this eutrophication.

Nitrogen is the limiting nutrient for coastal waters and excess nitrogen inputs into these waters create large algal blooms that eventually die off and consume oxygen during decomposition. Nitrogen concentrations, particularly in the nitrate-nitrogen form, and fluxes from the Mississippi River Basin and others worldwide have increased dramatically in this century, particularly since 1950 with the rise in fertilizer use. Natural and created wetlands, as well as riparian buffers, are effective sinks for nitrate. When nitrate-nitrogen flows into wetlands or through anaerobic subsoils of riparian buffers, if sufficient organic carbon is available, high rates of denitrification are possible. Denitrification in freshwater systems primarily converts nitrate to nitrogen gas, which is then released back to the atmosphere.

To reduce the amount of nitrogen reaching freshwaters, it has been recommended to place wetlands between agricultural and livestock fields and streams, rivers and lakes. In total, the seven states of the upper Mississippi River Basin have lost 14.1 million ha over the past 200 years. These wetlands need to be replaced. Mitsch et al., 2001) recommend that 5 million acres of wetlands and 19 million acres of riparian forest should be created to produce a significant reduction in nitrate-nitrogen in the Mississippi River Basin.

However, it is unclear how the ability of wetlands to remove nitrogen, via denitrification, may be influenced by potential climate change as well as vegetation composition. It is necessary to understand how wetland plants commonly used in restoration projects grow during the first year to later investigate the potential retention of nitrogen.

To address this question, we planted 18 mesocosms (approximately 1 square meter) with either monocultures of *Schnoeplectus tabernaemontani* or *Scirpus sp*. or mixed cultures of both species. For each of the vegetation composition treatments, either standing water (i.e. wet) or conditions of subsoil saturation occurred (i.e. dry). We measured plants over their first growing season.

Schnoeplectus grew well in wet conditions, and even possessed more stems when grow in mixed versus monoculture. In contrast, *Scirpus* had longer leaves in dry water level treatments and competed against with *Schnoeplectus* under dry, but not wet, conditions. Overall, biomass of both species seems to be reduced under dry soil conditions. The next step is to evaluate the ability of these communities to retain nitrate. In summer of 2002, we will add excess nitrate to all treatments and measure rates of denitrification and plant production. With this knowledge, we will gain a better understanding of how climatic changes (i.e. manifest in changes in water levels) may change the ability of wetland buffers to uptake nitrogen.

The inherent complexity of wetlands requires more basic research to gain a complete understanding of the links between hydrological alterations and biogeochemical cycling. We are using mesocosms experiments to address two objectives:

Objective #1: To discover how different hydrologic regimes affect 1st season wetland plant growth in mono- versus mixed cultures.

Objective #2: To test the nitrate retention ability of different wetland plants under different hydrologic regimes.

Methods

We planted 18 mesocosms (1 m^2 x 0.6 m depth) at the Olentangy River Wetland Research Park, a 12-ha facility located near the campus of The Ohio State University. All previous sediment and gravel was removed from the mesocosms in April 2001. The bottom of each mesocosm contained 10-12-cm of newly washed, round, noncalcareous river pea gravel. The gravel reached over the drain to the standpipe that occurred over a French drain. On top of the gravel, we added 30-cm of wetland soil (highly organic). In this soil, we planted 4 plants (from Wildlife Nurseries in Wisconsin) in each of the mesocosms. *Schnoeplectus tabernaemontani* and *Scirpus sp.* occurred in either monoculture or mixed cultures.

At the beginning of the project (May 2001), we created flooded conditions by inserting a standpipe to maintain standing water. These flooded conditions were necessary to initially establish early plant growth. In June 2001, we removed the standpipes in half of the mesocosms to create soil-saturated conditions versus the standing water conditions that occurred when the standpipes were in place. Therefore, by planting different plants and creating water levels, we established mini-wetlands with mono- or mixed cultures of *Schnoeplectus* and *Scirpus*, at both low (soil-saturated) and high (standing) water levels. To examine plant competition, we measured the number of stems (*Schnoeplectus*), leaves (*Scirpus*), and length of the longest leaf or stem (both plants) over the course of the growing season (25 May 2001 to 9 October 2001). Dead biomass in the mesocosms was left over winter to provide carbon for spring growth.

Preliminary Results

Schnoeplectus likes wet conditions, but does better with competition. *Schnoeplectus* does not grow well under dry conditions. For total number of stems (Figure 1), hydrology seems limiting there as no effect of competition is seen under dry conditions (i.e., no difference between mono and mixed cultures). However, for plant height (Figure 2), *Schnoeplectus* in the mixed cultures grew faster than *Schnoeplectus* monocultures under dry conditions.

Scirpus does not compete well with *Schnoeplectus* in wet conditions. For example, mixed cultures under wet conditions had the lowest total number of leaves. However, total number of leaves varied a lot between treatments (Figure 3). Patterns are difficult to detect for mixed treatments. There was no final difference between *Scirpus* in wet monocultures and mixed dry cultures. Although large differences did not exist between treatments for the length of the longest leaf (Figure 4), *Scirpus* grow in mixed culture under dry conditions were longer.

Method Plans for Summer 2002

- Add nitrogen to mesocosms in the growing season
- In late August, harvest aboveground biomass by cutting stems at soil surface.
- Harvest belowground biomass with core samplers.

References

Mitsch, William J. , John W. Day, Jr., J. Wendell Gilliam, Peter M. Groffman, Donald L. Hey, Gyles W. Randall, and Naiming Wang. 2001. Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River Basin: Strategies to counter a persistent ecological problem. BioScience 51: 373-388.

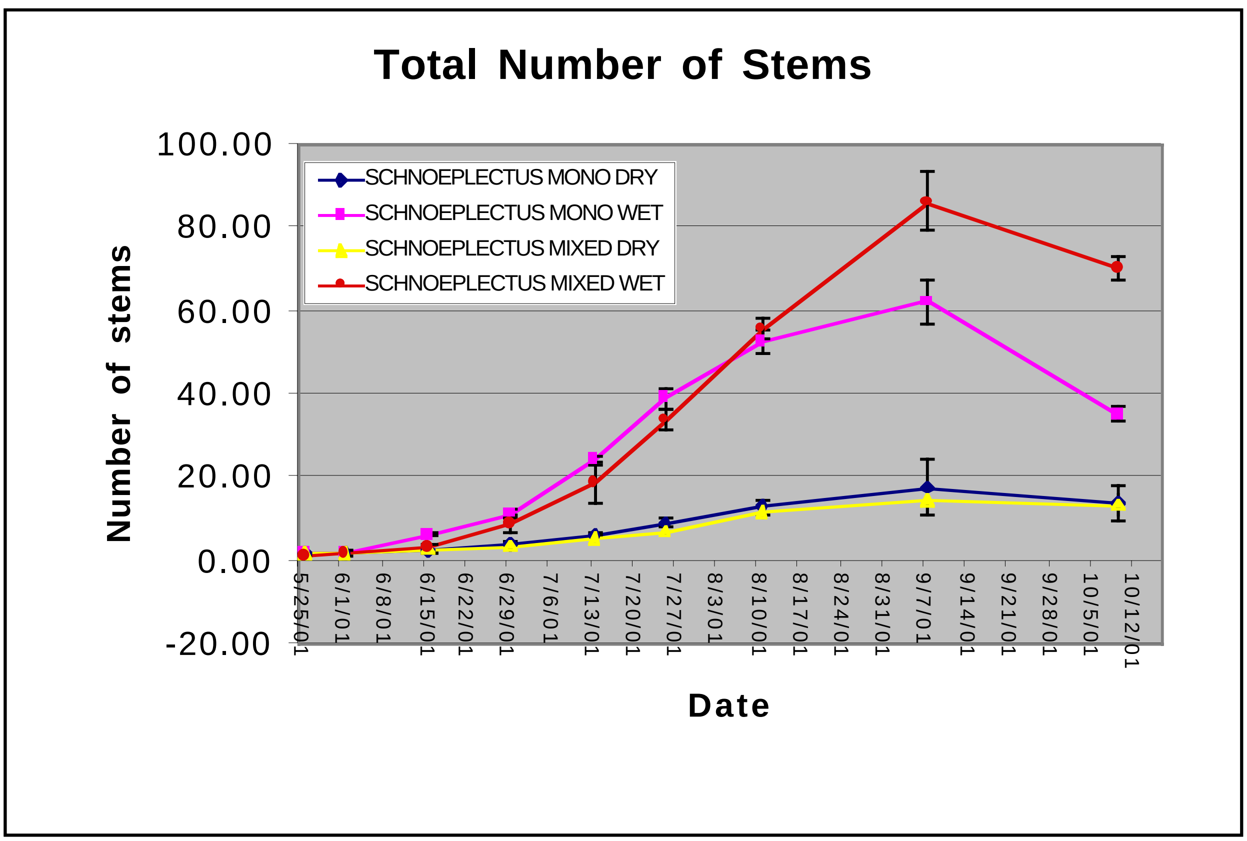

Figure 1. Number of stems of *Schenoplectus tabenaemontani* in 2001 in treatmetns

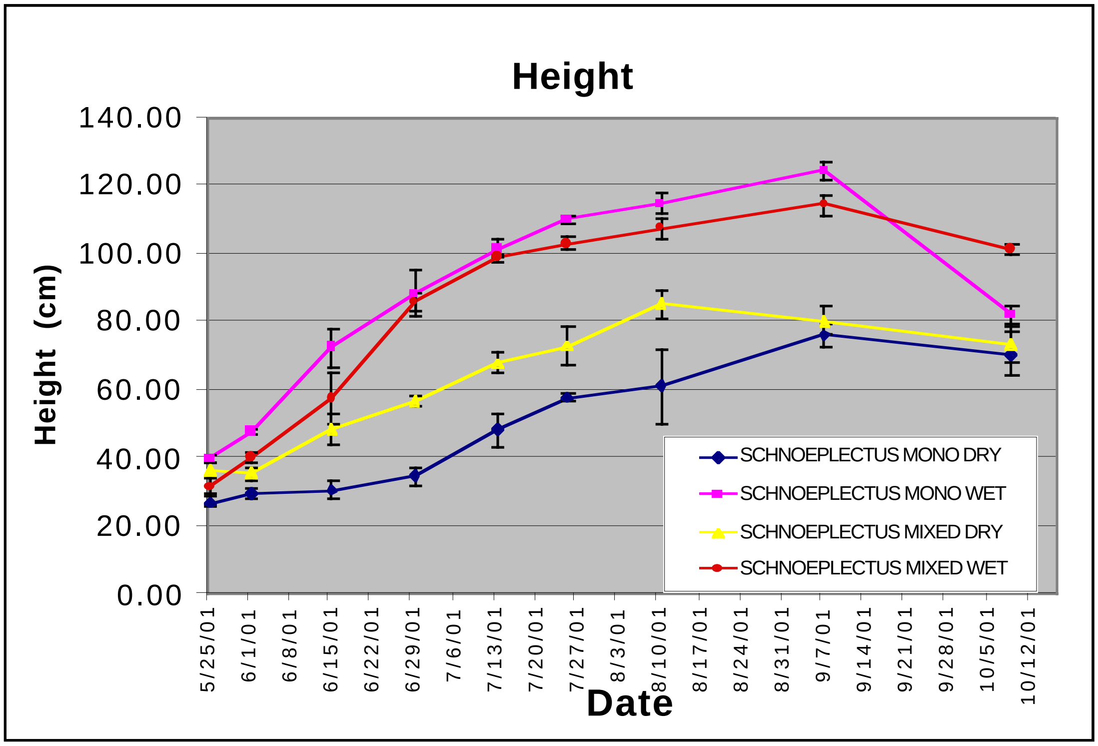

Figure 2. Height of tallest stem of *Schenoplectus tabernaemontani* in treatmetns

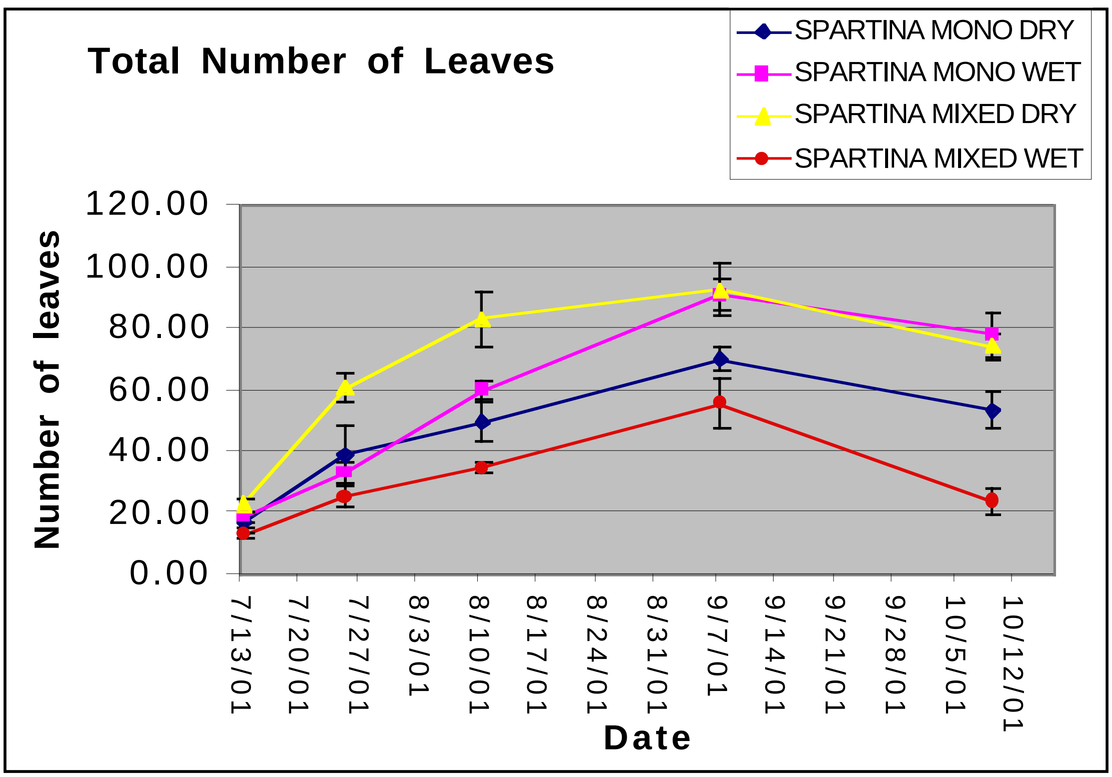

Figure 3. Total number of leaves of *Spartina* in treatments

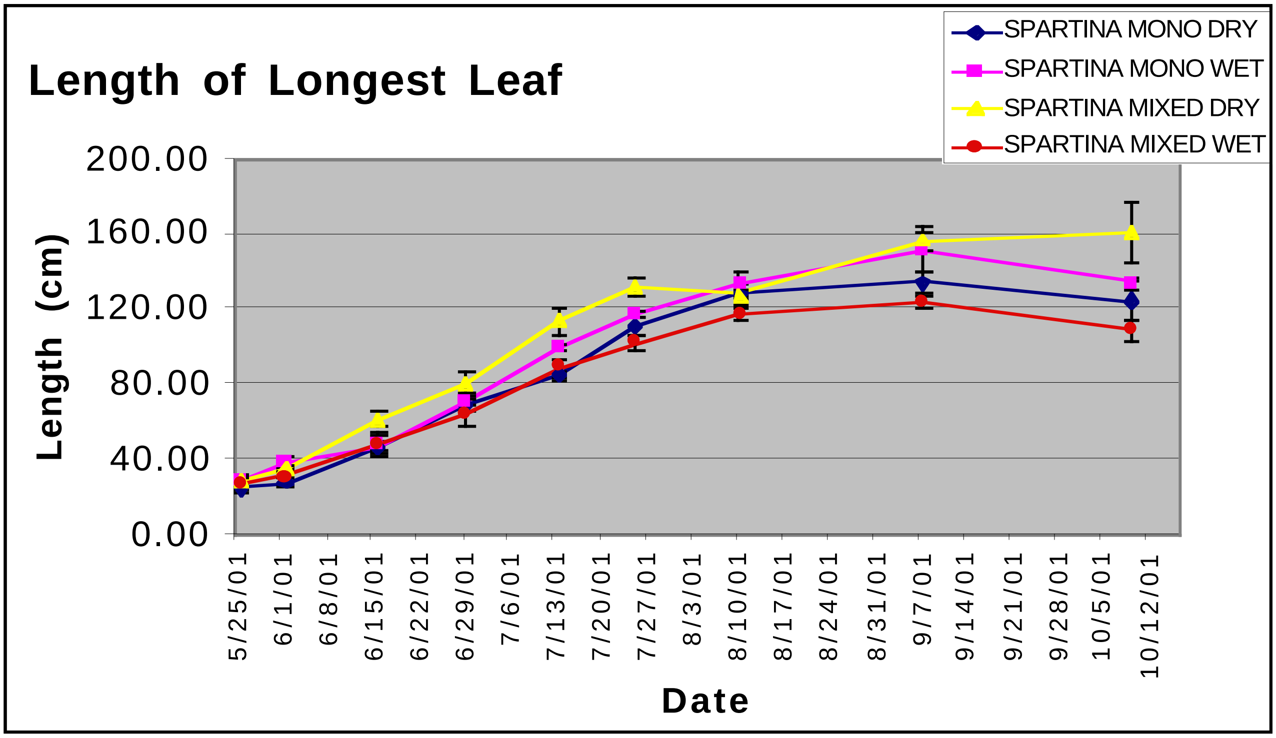

Figure 4. Length of longest leaf of *Spartina* in treatments